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Association of Knowledge and Attitudes with Compliance to Standard Operating Procedures for Infectious Material Handling Among Clinical Pathology Laboratory Personnel

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ABSTRACT

Compliance with Standard Operating Procedures (SOPs) for handling infectious materials is essential for preventing laboratory-acquired infections and ensuring occupational safety among laboratory personnel. Although knowledge and attitudes are commonly considered determinants of compliance, evidence regarding their influence on adherence to infectious material handling procedures remains inconsistent. This study aimed to examine the relationship between knowledge and attitudes of Clinical Pathology Laboratory personnel and compliance with SOPs for handling infectious materials at Buleleng District General Hospital. An analytical cross-sectional study was conducted involving all Clinical Pathology Laboratory personnel (n = 31). Data were collected using validated questionnaires assessing knowledge and attitudes, while SOP compliance was evaluated through direct observation. Statistical analysis was performed using the Spearman Rank correlation test. The findings revealed that 80.6% of respondents had good knowledge, 51.6% demonstrated positive attitudes, and 87.1% were compliant with infectious material handling SOPs. Spearman correlation analysis showed no significant association between knowledge and SOP compliance (p = 0.312) or between attitudes and SOP compliance (p = 0.269). These findings indicate that compliance with infectious material handling SOPs may be influenced more by situational and organizational factors, including workload, time constraints, work habits, availability of facilities and personal protective equipment, and supervisory practices, rather than by knowledge and attitudes alone. Strengthening

organizational support and safety culture may therefore be necessary to improve SOP compliance in clinical laboratory settings.

***Keywords**: Knowledge, Attitude, SOP Compliance, Infectious Materials, Laboratory Personnel*

ABSTRAK

Kepatuhan terhadap Standar Operasional Prosedur (SOP) penanganan bahan infeksius merupakan aspek penting dalam pencegahan infeksi akibat kerja dan perlindungan keselamatan petugas laboratorium. Meskipun pengetahuan dan sikap sering dianggap sebagai faktor yang memengaruhi kepatuhan, bukti mengenai pengaruh keduanya terhadap penerapan SOP penanganan bahan infeksius masih menunjukkan hasil yang beragam. Penelitian ini bertujuan untuk menganalisis hubungan pengetahuan dan sikap petugas Laboratorium Patologi Klinik terhadap kepatuhan SOP penanganan bahan infeksius di RSUD Kabupaten Buleleng. Penelitian ini menggunakan desain analitik dengan pendekatan cross-sectional yang melibatkan seluruh petugas Laboratorium Patologi Klinik sebanyak 31 orang. Data dikumpulkan menggunakan kuesioner pengetahuan dan sikap yang telah divalidasi, serta lembar observasi untuk menilai kepatuhan terhadap SOP. Analisis data dilakukan menggunakan uji korelasi Spearman Rank. Hasil penelitian menunjukkan bahwa 80,6% responden memiliki pengetahuan baik, 51,6% memiliki sikap positif, dan 87,1% patuh terhadap SOP penanganan bahan infeksius. Hasil uji statistik menunjukkan tidak terdapat hubungan yang signifikan antara pengetahuan dengan kepatuhan SOP ($p = 0,312$) maupun antara sikap dengan kepatuhan SOP ($p = 0,269$). Temuan ini menunjukkan bahwa kepatuhan terhadap SOP penanganan bahan infeksius kemungkinan lebih dipengaruhi oleh faktor situasional dan organisasi, seperti beban kerja, keterbatasan waktu, kebiasaan kerja, ketersediaan sarana dan alat pelindung diri, serta pengawasan dari pimpinan, dibandingkan oleh faktor pengetahuan dan sikap semata. Penguatan budaya keselamatan kerja dan dukungan organisasi diperlukan untuk meningkatkan kepatuhan SOP di lingkungan laboratorium klinik.

Kata Kunci: Pengetahuan, Sikap, Kepatuhan SOP, Bahan Infeksius, Petugas Laboratorium

INTRODUCTION

Clinical laboratories play a critical role in healthcare services by performing examinations of clinical specimens to support disease diagnosis, treatment monitoring, and health recovery. Clinical specimens include blood, urine, cerebrospinal fluid, feces, sputum, pleural fluid, peritoneal fluid, wound exudates, and other biological materials that may contain pathogenic microorganisms such as bacteria, viruses, fungi, and parasites. Consequently, these materials are classified as infectious substances and require appropriate handling procedures to prevent occupational exposure and laboratory-acquired infections(1–3). Handling infectious materials in Clinical Pathology Laboratories poses significant occupational hazards, including biological contamination, accidental exposure to pathogenic microorganisms, needle-stick injuries, and transmission of infectious diseases such as hepatitis B, human immunodeficiency virus (HIV), and tuberculosis. Laboratory personnel are continuously exposed to potentially infectious specimens during specimen collection, transportation, processing, analysis, and disposal. Therefore, strict adherence to Standard Operating Procedures (SOPs) is essential to minimize occupational risks, ensure laboratory biosafety, and maintain the quality of laboratory services(4,5).

Medical Laboratory Technologists (MLTs) are healthcare professionals responsible for performing laboratory examinations, measurements, and analyses of biological specimens to assist in disease diagnosis and patient management. Due to the nature of their work, MLTs are expected to consistently comply with SOPs related to infectious material handling, including the use of personal protective equipment (PPE), specimen labeling, packaging, transportation, disinfection, and waste disposal procedures(6). Compliance with these procedures is considered a key component of laboratory quality assurance and occupational safety programs.

According to health behavior theories, knowledge and attitudes are important determinants of individual behavior and may influence compliance with safety procedures in healthcare settings(2,7,8). Adequate knowledge enables laboratory personnel to understand the risks associated with infectious materials and the importance of preventive measures, while positive attitudes may encourage consistent implementation of safety practices. However, behavioral compliance is often influenced by multiple factors beyond individual knowledge and attitudes, including training, workload, supervision, organizational culture, availability of resources, and workplace environment(9,10).

Previous studies have reported inconsistent findings regarding the relationship between knowledge, attitudes, and compliance with laboratory safety procedures. Munawaroh et al. reported a positive association between knowledge, attitudes, and compliance with tuberculosis sputum specimen handling procedures among laboratory personnel(10). Conversely, Rizkika et al. found that a substantial proportion of healthcare workers demonstrated negative attitudes toward biosafety protocols despite having adequate knowledge, suggesting that compliance may be influenced by additional organizational and environmental factors(11). These findings indicate that the relationship between knowledge, attitudes, and SOP compliance remains inconclusive and requires further investigation, particularly in different laboratory settings.

At Buleleng District General Hospital, reports from the first quarter of 2025 identified nine cases of non-conformity related to infectious material handling, including errors in specimen packaging, labeling, specimen container utilization, personal protective equipment use, and disinfection procedures. Such incidents may compromise laboratory quality, increase the risk of cross-contamination, and expose personnel to occupational hazards. Despite the implementation of SOPs, factors contributing to compliance among laboratory personnel have not been systematically evaluated.

The novelty of this study lies in its examination of the relationship between knowledge, attitudes, and compliance with infectious material handling SOPs among Clinical Pathology Laboratory personnel within a hospital-based laboratory setting. Unlike previous studies that primarily focused on laboratory safety knowledge or general biosafety practices, this study specifically investigates compliance with infectious material handling procedures while considering both cognitive and behavioral factors. The findings are expected to provide evidence for strengthening laboratory safety programs, improving risk management strategies, and enhancing compliance with biosafety standards.

Therefore, this study aimed to determine the relationship between knowledge and attitudes of Clinical Pathology Laboratory personnel and compliance with Standard Operating Procedures for handling infectious materials at Buleleng District General Hospital..

METHODS

This study employed an analytical quantitative design with a cross-sectional approach to examine the relationship between knowledge and attitudes of Clinical Pathology

Laboratory personnel and their compliance with Standard Operating Procedures (SOPs) for handling infectious materials at Buleleng District General Hospital.

The study was conducted at the Clinical Pathology Laboratory of Buleleng District General Hospital, Bali, Indonesia, from October to November 2025. The study population consisted of all laboratory personnel working in the Clinical Pathology Laboratory during the study period. A total sampling technique was applied, resulting in 31 laboratory personnel being included as study participants.

Data collection was performed using structured questionnaires and direct observation. The questionnaire was designed to assess respondents' knowledge and attitudes regarding infectious material handling SOPs. Knowledge was evaluated through questions related to biosafety principles, personal protective equipment (PPE), specimen handling, disinfection procedures, and infectious waste management. Attitudes were assessed using statements measuring respondents' perceptions, awareness, and commitment toward laboratory safety practices. Compliance with infectious material handling SOPs was evaluated using an observation checklist based on institutional SOP guidelines, including the use of PPE, specimen labeling and packaging, transportation procedures, disinfection practices, and infectious waste disposal.

The independent variables in this study were knowledge and attitudes of laboratory personnel, while the dependent variable was compliance with SOPs for handling infectious materials. Data obtained from questionnaires and observations were coded and analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to summarize respondent characteristics and variable distributions. The relationship between knowledge, attitudes, and SOP compliance was analyzed using the Spearman Rank Correlation test because the data were ordinal in nature. A p-value of less than 0.05 was considered statistically significant.

All respondents participated voluntarily after receiving an explanation of the study objectives and procedures. Confidentiality and anonymity of participants were maintained throughout the research process in accordance with ethical principles for human subject research.

RESULTS

A total of 31 Clinical Pathology Laboratory personnel involved in infectious material handling at Buleleng District General Hospital participated in this study. Respondent characteristics included age, sex, educational level, and length of employment.

Table 1. Characteristics of Respondents (n = 31)

Characteristic	Frequency (n)	Percentage (%)
Age (years)		
20–29	12	38.7
30–39	13	41.9
40–49	5	16.1
≥50	1	3.2
Sex		
Male	8	25.8
Female	23	74.2
Length of Employment		
<5 years	8	25.8
5–10 years	12	38.7
>10 years	11	35.5

Educational Level		
Diploma III in Medical Laboratory Technology	30	96.8
Applied Bachelor in Medical Laboratory Technology	1	3.2

As shown in Table 1, most respondents were aged 30–39 years (41.9%), female (74.2%), had 5–10 years of work experience (38.7%), and held a Diploma III qualification in Medical Laboratory Technology (96.8%).

Knowledge of Infectious Material Handling SOPs

The distribution of respondents according to knowledge level regarding infectious material handling SOPs is presented in Table 2

Table 2. Knowledge Levels Regarding Infectious Material Handling SOPs

Knowledge Category	Frequency (n)	Percentage (%)
Good (>75%)	25	80.6
Moderate (55–75%)	4	12.9
Poor (<55%)	2	6.5
Total	31	100.0

Most respondents demonstrated good knowledge regarding infectious material handling SOPs (80.6%), indicating adequate understanding of laboratory biosafety procedures and occupational safety requirements.

Attitudes Toward Infectious Material Handling SOPs

The distribution of respondents according to attitude toward SOP implementation is presented in Table 3.

Table 3. Attitudes Toward Infectious Material Handling SOPs

Attitude Category	Frequency (n)	Percentage (%)
Positive	16	51.6
Negative	15	48.4
Total	31	100.0

More than half of the respondents (51.6%) demonstrated positive attitudes toward SOP implementation, reflecting favorable perceptions regarding laboratory safety practices and infection prevention measures.

Compliance with Infectious Material Handling SOPs

The level of compliance with infectious material handling SOPs is shown in Table 4.

Table 4. Compliance with Infectious Material Handling SOPs

Compliance Category	Frequency (n)	Percentage (%)
Compliant	27	87.1
Non-compliant	4	12.9
Total	31	100.0

Most laboratory personnel (87.1%) were compliant with infectious material handling SOPs. Nevertheless, several non-conformities were observed, particularly regarding needle recapping practices, inconsistent use of personal protective equipment (PPE), and workplace hygiene management.

Association Between Knowledge and SOP Compliance

The relationship between knowledge level and compliance with infectious material handling SOPs was analyzed using the Spearman Rank correlation test.

Table 5. Association Between Knowledge and SOP Compliance

Knowledge Level	Non-compliant n (%)	Compliant n (%)
Good	4 (12.9)	21 (67.7)
Moderate	0 (0.0)	4 (12.9)
Poor	0 (0.0)	2 (6.5)
Total	4 (12.9)	27 (87.1)

Spearman Rank test: p = 0.312

The Spearman Rank correlation analysis revealed no statistically significant association between knowledge level and SOP compliance (p = 0.312). Notably, four respondents with good knowledge demonstrated non-compliance, whereas two respondents with poor knowledge were found to comply with SOP requirements.

Association Between Attitudes and SOP Compliance

The relationship between attitudes and SOP compliance was also analyzed using the Spearman Rank correlation test.

Table 6. Association Between Attitudes and SOP Compliance

Attitude	Non-compliant n (%)	Compliant n (%)
Positive	1 (3.2)	15 (48.4)
Negative	3 (9.7)	12 (38.7)
Total	4 (12.9)	27 (87.1)

Spearman Rank test: p = 0.269

The analysis demonstrated no statistically significant association between attitudes and compliance with infectious material handling SOPs (p = 0.269). One respondent with a positive attitude was observed to be non-compliant, whereas three respondents with negative attitudes were found to comply with SOP requirements.

Overall, the findings indicate that although most respondents demonstrated good knowledge, positive attitudes, and high compliance with infectious material handling SOPs, neither knowledge nor attitudes showed a statistically significant relationship with SOP compliance among Clinical Pathology Laboratory personnel at Buleleng District General Hospital.

DISCUSSION

This study examined the relationship between knowledge and attitudes of Clinical Pathology Laboratory personnel and compliance with Standard Operating Procedures (SOPs) for handling infectious materials at Buleleng District General Hospital. The findings revealed that most respondents demonstrated good knowledge (80.6%), positive attitudes (51.6%), and high compliance with infectious material handling SOPs (87.1%). However, statistical analysis showed no significant association between knowledge and SOP compliance (p = 0.312) or between attitudes and SOP compliance (p = 0.269). These findings suggest that compliance with infectious material handling SOPs may be influenced by factors beyond individual cognitive and attitudinal characteristics.

The majority of respondents demonstrated good knowledge regarding infectious material handling procedures, indicating adequate understanding of biosafety principles,

personal protective equipment (PPE) utilization, specimen management, disinfection procedures, and infectious waste disposal. Nevertheless, several respondents with good knowledge were still categorized as non-compliant with SOP requirements. This finding indicates that knowledge alone may not be sufficient to ensure safe laboratory practices. According to health behavior theory, knowledge is considered a predisposing factor for behavior formation; however, the translation of knowledge into practice is frequently influenced by environmental and organizational factors(12,13). In laboratory settings, high workload, time constraints, routine work habits, and operational pressures may reduce adherence to established procedures despite adequate theoretical understanding.

Observational findings identified several recurring non-conformities, including improper needle recapping practices, inconsistent use of PPE, inadequate disinfection of work surfaces before and after laboratory activities, failure to label infectious materials appropriately, and limited use of eye protection during specimen handling. Similar findings have been reported by Rizkika et al., who observed that inadequate supervision, insufficient biosafety training, and lack of enforcement mechanisms contributed to non-compliance with infectious material handling procedures among laboratory personnel(14,15). These findings indicate that procedural deviations may occur despite sufficient knowledge of biosafety protocols.

Interestingly, this study also identified respondents with limited knowledge who nevertheless demonstrated compliance with SOP requirements. This finding suggests that practical experience, workplace discipline, routine supervision, and organizational expectations may exert a stronger influence on compliance behavior than knowledge alone. Laboratory personnel with relatively short work experience may adhere strictly to SOPs due to adaptation processes and close supervision, whereas personnel with longer experience may develop procedural discipline through repeated practice and operational familiarity. Therefore, compliance appears to be a multidimensional behavior shaped by both individual and organizational determinants rather than by knowledge alone.

The absence of a significant relationship between knowledge and SOP compliance is consistent with previous findings reported by Arifin, who demonstrated that knowledge was not significantly associated with compliance toward occupational SOP implementation among healthcare workers(16). Similar studies have suggested that educational background, motivation, work experience, organizational support, and supervisory systems may exert greater influence on safety-related behaviors than knowledge itself. Consequently, interventions aimed solely at increasing knowledge may be insufficient to improve compliance if they are not accompanied by organizational strategies that reinforce safe work practices.

This study also demonstrated no statistically significant association between attitudes and compliance with infectious material handling SOPs. Although more than half of the respondents exhibited positive attitudes toward SOP implementation, positive attitudes did not consistently translate into compliant behavior. One respondent with a positive attitude was identified as non-compliant, while several respondents with negative attitudes remained compliant with SOP requirements. These findings indicate a discrepancy between attitudinal disposition and actual workplace behavior. According to Notoatmodjo, attitudes reflect an individual's tendency to evaluate or respond favorably toward a particular object or practice; however, attitudes alone may not directly determine behavior, particularly within structured organizational environments where behavior is influenced by external regulations and professional responsibilities(17).

Several factors may explain the inconsistency between attitudes and compliance. Laboratory personnel frequently operate in environments characterized by high workloads, urgent turnaround times, staffing limitations, and competing operational priorities. Under

such conditions, employees may occasionally prioritize efficiency over strict procedural compliance. In addition, long-term work experience may lead some personnel to rely on established habits rather than formal SOP requirements. Conversely, individuals with less favorable attitudes may still comply with SOPs because of institutional regulations, supervisory oversight, or concerns regarding professional accountability. These findings suggest that compliance behavior is shaped by a complex interaction between personal beliefs and workplace conditions.

The findings of this study are consistent with previous studies indicating that positive attitudes alone do not necessarily translate into compliant safety behavior in healthcare settings. According to Neal and Griffin, safety compliance is influenced not only by individual attitudes but also by organizational safety climate, supervisory support, and management commitment to workplace safety(18). Similarly, DeJoy et al. reported that employee compliance with safety procedures is shaped by a combination of personal, environmental, and organizational factors rather than by individual perceptions alone(19). While positive attitudes may increase awareness and motivation, actual compliance often depends on enabling and reinforcing factors such as resource availability, leadership commitment, workplace culture, and effective monitoring systems. Therefore, compliance should be regarded as a multidimensional outcome requiring integrated interventions at both individual and organizational levels.

A notable contribution of this study is the demonstration that high levels of knowledge and positive attitudes do not necessarily translate into higher compliance with infectious material handling SOPs. Unlike previous studies that primarily focused on knowledge and attitudes as determinants of safety behavior, this study highlights the substantial influence of organizational and situational factors in shaping compliance behavior among Clinical Pathology Laboratory personnel. These findings emphasize that improving compliance requires not only educational interventions but also strengthening laboratory safety culture, supervisory mechanisms, availability of biosafety facilities, periodic audits, and leadership commitment to occupational safety. This perspective provides additional evidence supporting the growing concept that safety culture is a stronger predictor of biosafety compliance than individual cognitive factors alone(20).

Several limitations should be considered when interpreting the findings of this study. First, knowledge and attitude data were collected using self-administered questionnaires, which may be subject to response bias and social desirability bias. Second, the relatively small sample size and single-center study design may limit the generalizability of the findings. Third, compliance observations were conducted during a limited observation period and may not fully reflect long-term workplace behavior. Future studies should include larger multicenter samples and examine additional variables such as leadership support, safety climate, workload, organizational culture, and training effectiveness to better understand determinants of SOP compliance among laboratory personnel.

CONCLUSION

This study demonstrated that Clinical Pathology Laboratory personnel at Buleleng District General Hospital generally exhibited good knowledge, positive attitudes, and high compliance with Standard Operating Procedures (SOPs) for handling infectious materials. However, statistical analysis revealed no significant relationship between knowledge and SOP compliance, nor between attitudes and SOP compliance. These findings indicate that compliance with infectious material handling procedures is not determined solely by individual cognitive and attitudinal factors. Instead, compliance appears to be influenced by a broader interaction of organizational, environmental, and situational factors, including

workload, workplace culture, supervisory practices, availability of facilities and personal protective equipment, and institutional commitment to biosafety standards. The findings highlight the importance of adopting a comprehensive approach to improving biosafety compliance in clinical laboratories. Efforts aimed exclusively at increasing knowledge or promoting positive attitudes may not be sufficient to ensure consistent adherence to SOPs without adequate organizational support and reinforcement mechanisms.

Based on the findings of this study, laboratory management should strengthen supervisory systems and conduct regular monitoring and evaluation of SOP implementation to ensure sustained compliance among laboratory personnel. Periodic training and refresher programs on laboratory biosafety, infectious specimen handling, and occupational safety should be continuously implemented to reinforce safe work practices and maintain awareness of potential hazards. Furthermore, establishing a strong laboratory safety culture through effective risk communication, leadership engagement, and continuous quality improvement initiatives is highly recommended. For laboratory personnel, continuous professional development and active participation in biosafety programs are essential to maintain safe laboratory practices. Personnel are also encouraged to report procedural barriers, facility limitations, and safety concerns to support ongoing quality improvement and risk management efforts. Future studies should explore additional determinants of SOP compliance, including workload, organizational culture, leadership support, safety climate, availability of resources, motivation, and supervision. Research involving larger sample sizes, multicenter settings, and mixed-method approaches is recommended to provide a more comprehensive understanding of factors influencing biosafety compliance among laboratory personnel.

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